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Fremont Irrigation: Evidence from Gooseberry Valley, Central Utah

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Most Great Basin archaeologists appear to agree that the Fremont horticulturalists probably practiced some form of irrigation to raise their crops. In the past, when explicitly discussed, the argument has been based on three lines of indirect or unsubstantiated evidence. First, most areas where the Fremont are known to have grown crops presently receive insufficient rainfall for dry farming, and the same was probably true during Fremont times (e.g., Aikens 1967; Berry 1972; Lohse 1980). Second, the Fremont appear to have selectively settled in locations where natural runoff was available for providing additional moisture for their fields (e.g., Jennings and Sammons-Lohse 1981; Lohse 1980). Third, a number of authors have been told by local residents that, at the time of white settlement, the remains of prehistoric ditches were visible (Reagan 1930; Morss 1931; Gunnerson 1957; Lohse 1980). To date, however, no substantiating archaeological evidence for Fremont irrigation has been presented.

This paper reports the discovery and subsequent investigation of a buried channel in the alluvial flood plain of Gooseberry Valley in central Utah. The channel is located immediately east of Nawthis Village, a large Fremont habitation site which has been the focus of the University of Utah Archaeological Field School since 1978 (Jennings 1978; Metcalfe and O'Connell 1979; Jones and

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O'Connell 1981; Jones and Metcalfe 1981; Metcalfe 1983). Based on geomorphic and archaeological evidence, we argue that the buried channel is artificial and is, in all probability, the remains of a channel constructed and maintained by the inhabitants of Nawthis Village for the purpose of irrigating their crops.

Gooseberry Valley is located on the northern edge of the Fishlake Plateau, in Sevier County, central Utah (Fig. 1). The 120-square-kilometer drainage originates at an elevation of about 3,200 m. in the high country bordering Mt. Terrill and descends to 1,700 m. where Gooseberry Creek flows into Salina Creek, a major tributary of the Sevier River. Ten to fifteen percent of the drainage has been surveyed, and 173 prehistoric sites have been located and recorded, of which 63 are assigned to the Fremont archaeological complex based on radiocarbon dates and/or diagnostic artifacts (Metcalfe 1984). The largest of these Fremont sites is Nawthis Village (42SV633), which consists of an estimated 50 to 75 structures scattered over 7.5 hectares.

Nawthis Village is located in the central region of the drainage on the western terrace about 5 m. above Gooseberry Creek. The University of Utah has spent five field seasons excavating selected portions of Nawthis Village with the principal goal of collecting data relevant to reconstructing the subsistence economy of the people who occupied the site from about A.D. 800 to 1150. Horticultural products appear to have been an important part of the diet as evidenced by the recovery of abundant corn remains, and less commonly the remains of beans and squash. The terrace on which Nawthis Village is situated is not suitable for farming because of its stony sediments. We assume that the prehistoric horticultural fields were located across the creek on the alluvial flood plain.

Exceptionally high precipitation in late 1982 and early 1983 saturated the fine-grained sediments of the alluvial flood plain directly east of Nawthis Village and caused a massive mudflow and associated slumping on June 2, 1983 (Fig. 2). The two-hectare scar ranges in depth from about three to five meters and is bounded by nearly vertical exposures of flood-plain sediments that provided an opportunity to search for evidence of Fremont irrigation systems as well as to study the alluvial history of the valley.

A buried channel was identified in sediments exposed in the head scarp in the southeastern section of the scar. In cross section the channel is V-shaped, measuring about 1.3 m. wide across the top, 5 cm. wide at the bottom and reaching a depth of nearly 1.2 m. (Figs. 3 and 4c). The channel truncates two fine-grained, natural sedimentary units (Fig. 4: Units A and B), each of which exhibits soil development at its surface. The level of origin of the channel is the top of Unit B, about 95 cm. below the modern ground surface. The channel either retained its integrity during the subsequent deposition of about 50 cm. of alluvial sand (Unit C), or regained it sometime later. The surface of Unit C contains a high concentration of charcoal in the vicinity of the channel, and the sediment is fire-reddened to depths of about 5 cm. along the edge of the channel.

From bottom to top, channel deposits (Unit D) consist of: (1) a sand and gravel unit about 30 cm. thick (D1); (2) a gravel unit about 50 cm. thick with abundant subangular sandstone cobbles (D2); (3) a silt and sand unit about 20 cm. thick with uncharred wood fragments scattered throughout (D3); and (4) a silt and sand unit also about 20 cm. thick (D4). The channel deposits were then covered by additional flood-plain sediments (Unit E) and soil development followed.

The scar and buried channel are on privately owned land which presently is being used as irrigated pasture. The owners requested that we limit our examination of the

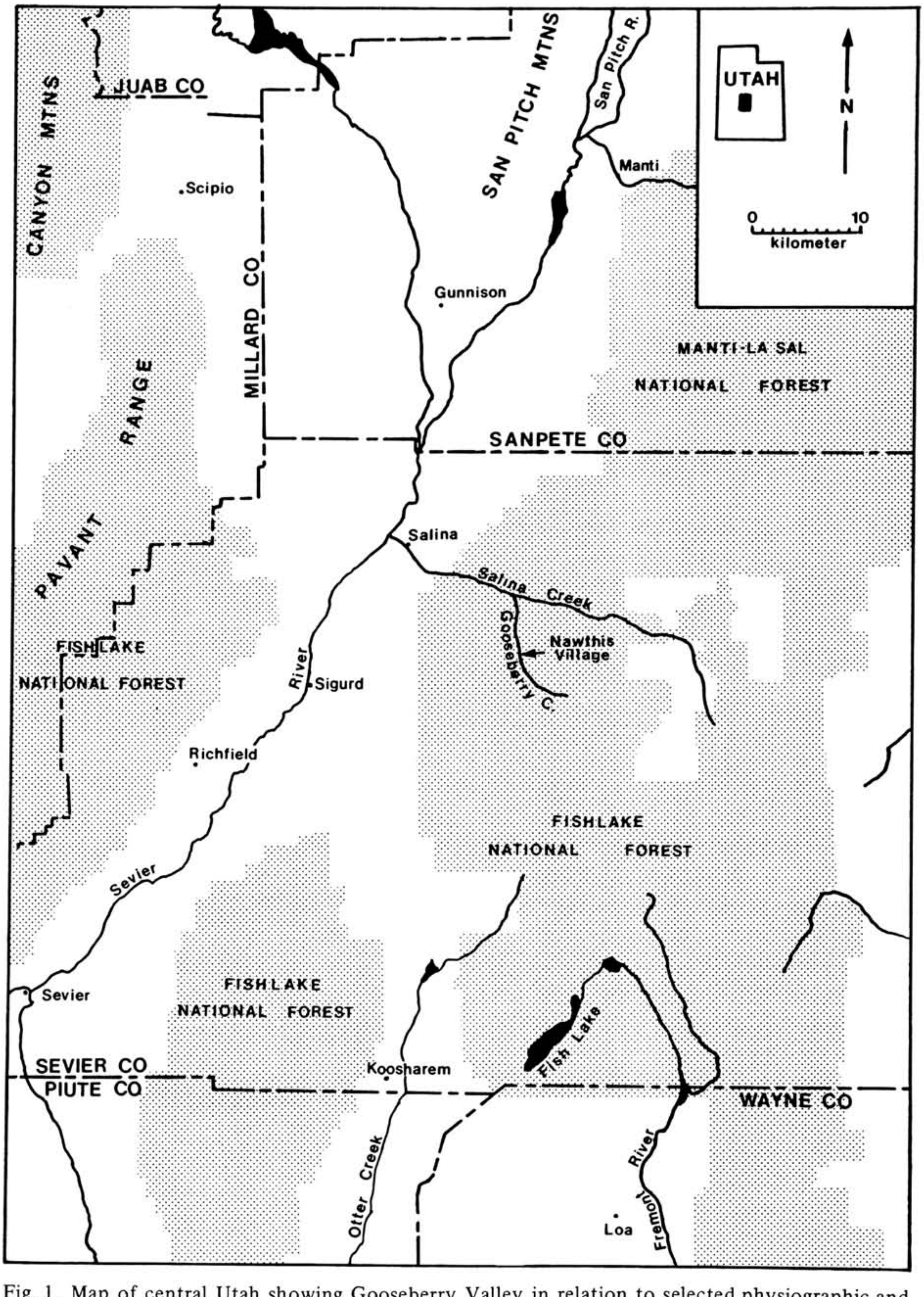

Fig. 1. Map of central Utah showing Gooseberry Valley in relation to selected physiographic and political features.

Fig. 2. Aerial view of the scar in the alluvial flood plain in Gooseberry Valley, facing east. Arrow indicates the location of the buried channel. Nawthis Village is located on the pinyon-juniper covered ridge in foreground; view includes the northern half of the site.

channel to the exposure in the scarp of the scar and a single exploratory trench placed within about five meters of the edge of the scar. Clearly, this severely constrained the types and character of the evidence we could gather. Nevertheless, a strong argument can be advanced that the buried feature represents an artificially constructed irrigation channel rather than a natural stream channel.

Although at least five episodes of filling are evident in the channel deposits, only two major cutting events are apparent. The first is the initial cutting of the V-shaped channel which occurred when Unit B was the surface of the flood plain (Fig. 4a). The second is the smaller U-shaped cut superimposed within the original channel. The level of origin of this second feature appears to be the surface of Unit C and its lower boundary is marked by large sandstone cobbles (D2) (Figs. 4b and 4c). We will describe the characteristics of these two features separately, but it should be noted that they may represent the cross sections of a single channel as it was originally constructed and as it was finally abandoned. We will return to this point later.

There is good evidence to suggest that the original V-shaped channel (Fig. 4a) is not a natural stream channel. The shape and symmetry of the channel's cross section are not typical of natural channels carrying sand and gravel. The shape of a natural channel reflects relationships among specific fluvial system variables, particularly sediment load.

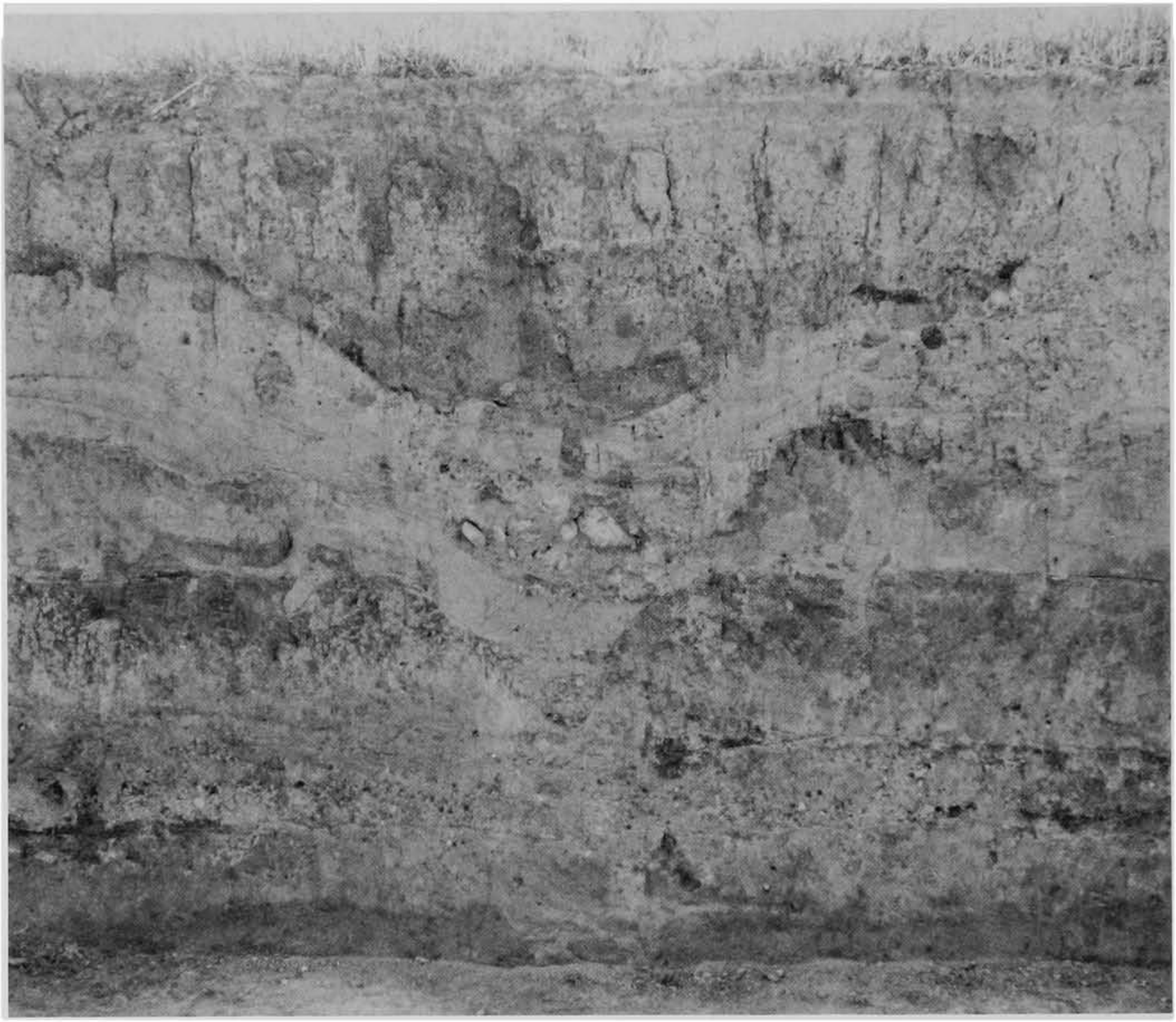

Fig. 3. Buried channel exposure in scarp.

In finer grained alluvium, like the silt and clay sedimentary units truncated by the buried channel, natural channel cross sections tend to approximate a catenary (U-shaped) curve. This shape minimizes surface area and friction and therefore provides for maximum transport of suspended load. Also, the cohesiveness of silt and clay banks tend to resist erosion (Leopold, Wolman, and Miller 1964; Bloom 1978). In coarser alluvium, natural channel cross sections tend to be trapezoidal (flat-floored) in straight reaches and asymmetrical at bends. This form is due to the bedload being transported near the bottom of the channel, which produces a velocity gradient that increases rapidly upward. The faster moving water can erode banks made of grain sizes similar to those already in transport as bedload. In addition, sand and gravel are relatively noncohesive and banks therefore tend to collapse readily, producing wide, flat-floored, shallow channels. Therefore, the V-shaped channel is inconsistent with expected natural cross-section shapes in alluvium, either coarse- or fine-grained.

Channel shape alone does not conclusively

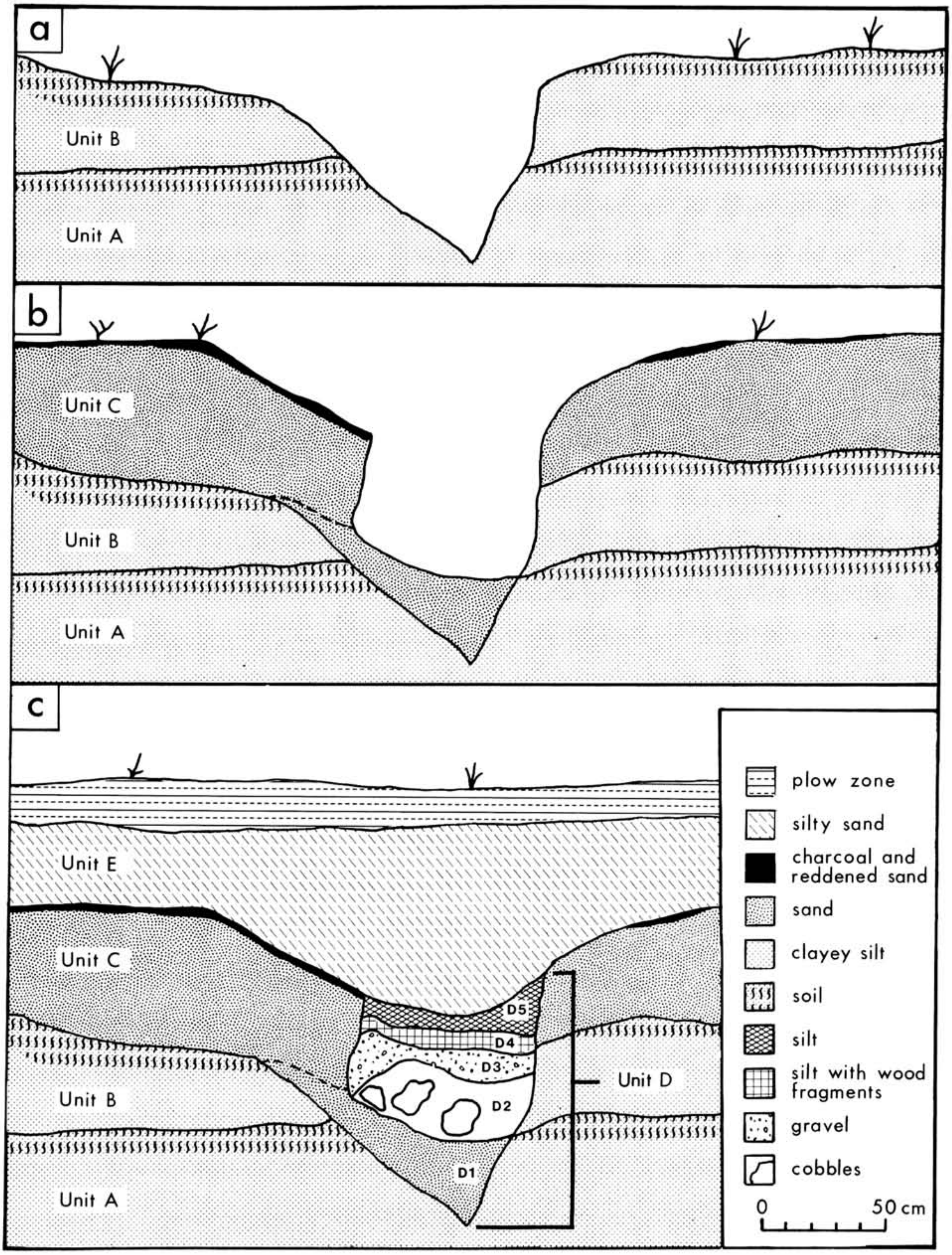

Fig. 4. Buried channel: (a) cross-section of original V-shaped channel; (b) cross-section of U-shaped channel; and (c) stratigraphic profile of the two channels as viewed in scarp exposure.

demonstrate that the channel functioned as an irrigation ditch. Most well-studied prehistoric irrigation ditches appear to be U-shaped in cross section (Woodbury and Neely 1972: 130; Haury 1976: 147-148), but V-shaped ditches have been noted (Woodbury 1961; Raab 1975: 300-301; Haury 1976: 141-142).

The smaller, interior U-shaped (Fig. 4b) channel is also unlikely to be the result of natural fluvial processes. The bottom of this channel is lined with large, subangular sandstone cobbles (D2) (Fig. 4). The competence of a small stream flowing through this channel would have been greatly exceeded by these large cobbles. Stream competence is the relationship between the mean velocity of a stream and the size of the particles that can be eroded or transported by it. While the precise relationship between eroding velocities and large particles is still imperfectly understood, the grain size that will remain in transport is an exponential function of the mean velocity (Bloom 1978). In other words, velocities required to transport 25-cm. cobbles, the average diameter of cobbles present, are hundreds of centimeters per second (Bloom 1978). The small channel on the low, sloping alluvial plain could not possibly accommodate a stream with that velocity and therefore the cobbles could not have been naturally deposited.

Second, although cycles of cutting and filling are natural fluvial processes, they tend to occur as the channel shifts laterally. These aggradational and degradational processes are a response of the fluvial system to changes in variables of the system, such as climate, vegetation, geology, sediment load, and discharge (Schumm 1977). These adjustments occur across space and over time, as a stream shifts its channel, aggrading or downcutting, across the alluvial plain. Evidence of natural adjustments involving lateral shifting is not present anywhere in the alluvial sequence exposed in the flood plain. Instead, the sequence is characterized by continuous vertical accretion with incipient soil development and a well-defined channel sequence which shows either continual occupation or periodic reoccupation by a stream.

Aside from the geomorphic evidence, there are two characteristics of this channel that are consistent with the proposition that it is a cultural feature. First, the charcoal staining and fire-reddening evident along the surface of the sand unit which bounds its upper edge (Unit C) indicates intense or repeated firing. The firing was extremely localized; evidence of it disappears within about two to three meters of the edge of the channel. This fire-reddening is consistent with the expected consequences of burning the vegetation which would have grown densely along the channel banks and which may have periodically choked the flow of water. In his study of Hohokam irrigation systems, Haury (1976: 148) suggested that the same mechanism may have been responsible for the concentrations of charcoal and burned earth noted along a small "echo" canal.

Second, the large cobbles found in the bottom of the channel may represent the remains of a check dam built to raise the water level sufficiently to divert it across nearby fields or into lateral channels. This technique is used to irrigate the pasture today. Alternatively, the cobbles may have been placed in the channel to slow the flow of water in order to stabilize its bed. Herold (1961: 103) suggested that rock check dams located in irrigation canals at Mesa Verde served the latter purpose.

Last, the available evidence indicates that the channels were roughly contemporary with the Fremont occupation of Nawthis Village (about A.D. 800 to A.D. 1150, based on cluster of mean radiocarbon dates), located only 250 m. to the west. A radiocarbon sample was recovered from the charcoal and fire-reddened surface of Unit C (Fig. 4c). The sample, which consisted of small and diffuse particles of charcoal in a sandy matrix, produced an age of 650 ±100 radiocarbon years B.P. (Beta-9236), or A.D. 1300. Although this date is more recent than the majority of the mean radiocarbon dates recovered from Nawthis Village, it is not significantly different at the 0.5 significance level from 12 of the 36 radiocarbon dates recovered from the site (t-test; Thomas 1976: 249-251). The radiocarbon date recovered from the channel postdates the origin of the more recent, U-shaped channel; the cutting of the V-shaped channel, and at least some of the channel filling events, occurred earlier.

Two lines of indirect evidence can be used to estimate the approximate date that the earlier, V-shaped channel was formed. Based on a ladder of radiocarbon dates taken from the alluvial sequence, the average sedimentation rate for the upper sequence (that portion above the channel's level of origin) is estimated to be about 0.08 cm./year (Larrabee 1984). Since the level of origin of the trench is 95 cm. below the present ground surface, this horizon was buried no later than about 1,200 B.P. or about A.D. 750 (95 cm./(0.08 cm./year) = 1,187.5 years).

This estimate is consistent with the dates from a pit structure (42SV1338) located in the alluvial flood plain about 650 m. north of the scar. The structure, buried by 1.2 m. of sediments, was noted when it was exposed by Porcupine Creek undercutting its banks. Charcoal samples were recovered from the burned remains of its roof in 1981, prior to the complete destruction of the structure by erosion the following year. Although direct stratigraphic comparisons between the structure and the buried channel could not be made, the notes and photographs taken during the recording and subsequent test excavation of the pit structure indicate that its level of origin was the upper soil horizon, the same as that for the buried channel. The charcoal samples produced two dates: 980 ±75 radiocarbon years B.P. (I-10842) and 1,150 ±100 radiocarbon years B.P. (UCR-1580), or about A.D. 970 and A.D. 800 respectively. Although the stratigraphic correlation between the pit structure and the buried channel is tentative, the radiocarbon ages agree quite well with the estimate based on the calculated sedimentation rate.

DISCUSSION

We have argued that the buried channel fortuitously exposed in the alluvial flood plain of Gooseberry Valley is unlikely to be the result of natural fluvial processes. Conversely, its characteristics are consistent with what might be expected for an irrigation channel. Large-scale exposure of the feature might resolve any uncertainty concerning the origin and function of the channel, but unfortunately there is little chance that such a project can be undertaken in the near future. Our interpretation of the channel has therefore been made on the evidence presented above.

Based on the presently available evidence, it is impossible to determine whether the V-shaped channel and the U-shaped channel represent two discrete features or the consequences of periodically maintaining a single channel during the time when the flood plain was aggrading. Under those circumstances, maintaining the carrying capacity of a channel would have necessitated a series of vertical shifts to accommodate the channel to the rising ground surface. This would produce a stratigraphic profile dominated by the outline of the channel as it was originally constructed and its outline at the time of its abandonment.

As noted earlier, most regional scholars have generally assumed that some form of irrigation would have been required in at least some areas; documenting the presence of Fremont ditch irrigation in a particular area does not entail a dramatic reassessment of this archaeological complex. There is no evidence to suggest that the channel is part of either a large or a complex irrigation system. If the irrigation system was comparatively simple, Nawthis Village probably had a population sufficiently large to have created and maintained it. On the other hand, that ditch irrigation was practiced in one locale does not necessarily invalidate the hypotheses about other types of irrigation practices having been important to the Fremont in other areas (e.g., Jennings and Sammons-Lohse 1981; Berry 1972). The ethnographic Hopi used a variety of techniques for water control and conservation depending on the local circumstances (Hack 1942). Equally complex patterns have been postulated for other sections of the prehistoric Southwest (Glassow 1980; Plog and Garrett 1972; Schoenwetter and Dittert 1968; Vivian 1974).

Aside from the discovery of the buried channel, the study of the alluvial sequence suggests a possible reason for the Fremont abandonment of Gooseberry Valley. As noted earlier, only two soil horizons are evident below the modern soil in the vicinity of the channel. The earlier predates the Fremont occupation of the valley; the second, which is the level of origin of the channel, is coincident with the Fremont occupation. These soils indicate periods of land-surface stability in an alluvial sequence which is otherwise interpreted as the result of continuous accretion due to overbank sheet floods from Hoodoo and Porcupine creeks, tributaries of Gooseberry Creek (Larrabee 1984). The dating of the trench and associated sedimentary units discussed earlier suggests that the alluvial flood plain was stable, allowing soil development sometime toward the beginning of the Fremont occupation. Prior to the abandonment of Nawthis Village, however, the alluvial sands which presently overlie the soil horizon in the alluvial sequence began to accumulate. The covering of the soil by sterile sand would have had a detrimental affect on the horticultural productivity of the prehistoric fields, eventually rendering them infertile. As horticultural productivity declined, we could expect either that the local population migrated to another area more suitable for farming, or else switched completely to a hunting-and-gathering subsistence base which may have just as effectively caused their disappearance in the local archaeological record in terms of the criteria traditionally used to define this archaeological complex.

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Ovate Pestles and an Isolated Processing Station in Interior Southern California

D. L. TRUE

Most archaeologists acknowledge the need to include all elements of the larger settlement - subsistence pattern in any consideration of a regional or local prehistory, and the value of small sites as sources of interpretative information has long been recognized. The inability of archaeologists, however, to place isolated processing stations which *lack* subsurface deposits and/or datable elements into meaningful interpretative contexts has resulted in a tendency to set such resources aside with minimal treatment once they have been recorded. Although this is a reasonable approach, and there is often very little that can be said about such milling stations, increasing concerns with subsistence - settlement details, and a revived interest in hunter - gatherer lifeways, make the systematic consideration of such cultural elements increasingly worth the investment of some research effort. This may be especially true since many milling stations are treated as expendable when considered as part of environmental impact or other cultural resource-related investigations.

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On the other hand, it might be argued that because of their nature many bedrock features have been spared, and that such sites are still common in most parts of southern California. This may be the case, but many of these sites are increasingly inaccessible for research purposes, and milling stations with processing tools *in situ* are becoming especially rare. The degree to which the presence or absence of such tools affects the interpretation of processing stations is unknown, but it is a facet of the cultural inventory that needs to be addressed while such resources are still available.

This report describes a small undistinguished bedrock processing station located on an unnamed drainage tributary to Tucalota Creek. The feature is situated at an elevation of 2,140 feet above sea level east of Colt Road not far from the junction of Colt and Barranca roads in western Riverside County (Fig. 1). It is proposed that this site has three characteristics worthy of comment:

1. As of the late 1970s the pestles used in the processing were still *in situ.*

2. The number of pestle-like artifacts present on this rock exceed the number of mortars by a factor of four to one (nine pestles to two mortars).

3. The pestle forms are ovate to nearly round in outline as opposed to the elongate forms often associated with bedrock mortars in the region at large. In addition to this difference in outline form, several of the pestles are characterized by multiple pounding surfaces, and all have clearly defined rubbing wear on one or both sides.

THE SITE

The site (CA-RIV-3026) consists of a bedrock outcropping with two small mortars and two incipient slick areas situated on its upper surface. It is located at the base of a hill